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The Behavior of Chicks on the Visual Cliff Aged 1-20 Minutes and 80-100 Minutes

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THE BEHAVIOR OF CHICKS ON THE VISUAL CLIFF AGED 1-20 MINUTES AND 80-100 MINUTES

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CHAPTER I

INTRODUCTION

The present study was concerned with some implications of certain recent experimentation on the discrimination of depth. One type of contemporary behavioral research on depth perception experimentation has been focused on an apparatus known as a "visual cliff".

The visual cliff simulates an actual cliff in the sense that there is a direct drop-off on both sides of a walk-way (center board). The visual cliff uses, as stated by Walk and Gibson (12), "The principle of a drop-off or graduated heights, but gives the animal a choice between a short drop-off on one side (shallow) of a center board and a long drop-off on the other side (deep)". This appearance is accomplished by using a large sheet of glass, divided in half, with patterned material (usually painted squares) directly beneath one half and several inches below the glass on the other side of the visual cliff. A center board is placed between the two halves. Animals are then individually placed on the center board. The side of the visual cliff (shallow or deep) to which an animal moves and the latency before moving have been the usual observations measured.

The patterned, ordinarily checkered, material directly beneath the glass corresponds to the shallow side of the visual cliff, whereas the checkered material several inches below the glass represents the deep side of the visual cliff. (See Figure 1).

Most contemporary experiments on the visual cliff have stemmed from reaction to, either supporting or refuting, the implications of a series of experiments conducted by Walk and Gibson (12). The over-all results of the Walk and Gibson experiments indicated that all types of animals studied on the visual cliff displayed evidence for discrimination of depth at the time of "locomotion". Walk and Gibson (12) have stated "in general, all of the animals studied discriminated visual depth (on the visual cliff) by the time locomotion was possible, but this time varied widely, even among terrestrial species". Walk and Gibson (12) state that "the results in general support a hypothesis of innate depth perception, though the presence of a certain kind of environment during growth may be important for late-maturing

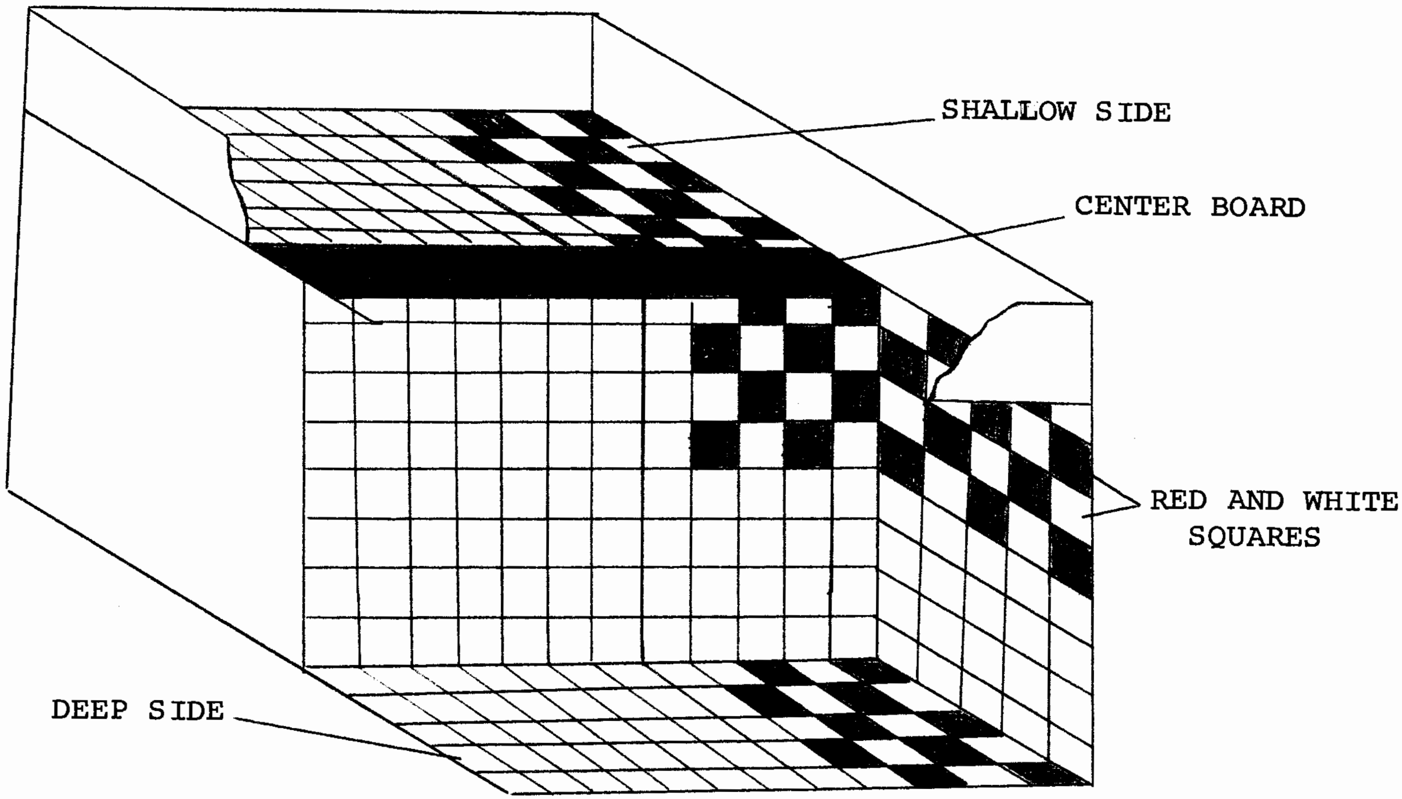

FIGURE 1

TRADITIONAL VISUAL CLIFF

animals". From one day-old chicks to six month-old humans, all have indicated a preference for the shallow side of the visual cliff.

Walk et. al. (13) raised rats for 90 days in the dark, tested them after 20 minutes of light adjustment, and found that they could significantly discriminate depth (descended to the shallow side) on the visual cliff. Nealey and Edwards (3) replicated Walk's study and observed that after 90 days of dark rearing and with only 20 minutes of light adaptation, rats discriminated depth (descended to the shallow side) on a visual cliff. Within Nealey and Edwards' subjects one group had patterned light adaptation and the other group had non-patterned light adjustment. Both groups discriminated depth perception with only 20 minutes of light adjustment. Nealey and Riley (4) observed that rats dark-reared for 300 days could not immediately (20 minutes of light adjustment) discriminate depth but after one month of light adjustment a significant proportion were able to perceive depth.

Studies on a similar visual cliff apparatus as that used by Walk and Gibson, by Routtenberg and Glickman (6), using infant hooded and albino rats; Rosemblum and Cross (5) employing three day-old Rhesus monkeys; Schiffman and Walk (8) employing 90 day-old hooded rats; and Routtenberg and Glickman (7) who studied undomesticated rodents, aquatic turtles, land turtles, and cats have supported the general conclusion that depth perception can be discriminated at the time of the animal's early locomotion.

The specific problem of the present experiment was to investigate the relationship between the discrimination of visual depth perception and the time of locomotion. Walk and Gibson (12) in their major studies conducted a series of experiments on "comparative difference and age factors". They observed that infant (25-29 day-old) hooded and albino rats descended to the shallow side of the visual cliff a significant number of times. When Walk and Gibson tested baby chicks (2-4 days-old) with the deep side of the visual cliff 25 inches below the center board, a significant number of subjects preferred the shallow side. When one day-old chicks were tested, with the deep side 10 inches below the center board, a significant number of subjects descended to the shallow side.

Kittens, state Walk and Gibson (12), aged 10 days, immediately after their eyes were open, failed to perform because of "inadequate motor coordination". Kittens at 27 days had adequate motor coordination and descended to the shallow side a significant number of times. Tallarico (10) tested three and nine hour-old light-reared chicks and found a significant preference among both age groups for the shallow side of the visual cliff. Fishman and Tallarico (1) tested three hour-old dark and light-reared chicks and concluded that "dark-reared chicks were as visually aware of depth as light-reared chicks". Both groups descended a significant number of times to the shallow side rather than the deep side of the visual cliff. Skinkman (9) observed that chicks aged 24 hours, tested on a visual cliff "exhibited unlearned visual depth discrimination".

The previously cited studies indicate that animals as young as three hours-old can discriminate depth perception on the visual cliff. But Tallarico and Farrell (11) and Kaess and Wilson (2) have demonstrated that the prior-to-testing environment has a significant effect upon which side of a visual cliff an animal descends. Tallarico and Farrell (11) used three different rearing environments:

shallow side environment, deep side environment, and a normal environment. The shallow side environment had large painted squares on the floor of the rearing cage optically equivalent in size to the squares on the shallow side of the visual cliff. The deep side environment had smaller squares, optically the size of squares on the deep side of the visual cliff, painted on the floor of the rearing cage. In other words, large squares were painted on the cage floor of the group that represented the shallow group while small squares were painted on the cage floor of the group that represented the deep group. The normal wood environment had no squares on the cage floor. When tested on the visual cliff a significant number of subjects descended to the side of the cliff that corresponded with their specific rearing environment. Animals raised with large squares moved to the side of the cliff with large squares; and, vice versa, animals reared with small squares descended to side with the small squares (deep side). Animals reared on the normal floor environment descended to the shallow side.

Kaess and Wilson (2) have also shown that visual depth perception was substantially influenced by the specific rearing conditions (simulating either side of the visual cliff). They raised rats for 28-30 days under conditions that simulated one or the other side of the visual cliff. Each group was reared in a cage with a glass floor. For one group the same checked pattern used on the testing visual cliff was placed several inches below the glass floor of the rearing cage. The other group was reared under identical conditions except the checked pattern material was directly beneath the glass floor. Observation indicated that rearing condition was an essential factor in the preferred direction of descent. These latter two studies suggest an oversimplification in the general hypothesis set forth by Walk and Gibson: that young animals at the onset of locomotion can discriminate depth perception.

Kaess and Wilson (2) and Tallarico and Farrell (11) used rats, 28-30 days old. Baby rats lack complete motor coordination at birth which usually results in a wait of several days before experimenting. The above authors demonstrated that a wait of several days and factors involved in that rearing time substantially influenced subjects' direction of descent. When Walk and Gibson tested rats (aged 25-33 days) the cage floors were flat; the floors did not give subjects equal chances of observing a deeper surface as in Kaess and Wilson's experiment or to view optically-different size squares as in Tallarico and Farrell's study. The cages used by Walk and Gibson represented the appearance of the shallow side of the visual cliff. The distance between the subject's eyes and the cage floor and the distance from the subject's eyes to the shallow side of the visual cliff were equal. Subjects were raised in a shallow side environment and they descended to the shallow side. The total data suggest that Walk and Gibson have failed to control for the possible learning of depth cues during the pre-experimental period.

The chick is a Poccocial Fowl which can therefore locomote immediately after hatching. If animals can discriminate at the onset of locomotion, as Walk and Gibson have hypothesized, then chicks should be able to exhibit discrimination of visual depth perception immediately after hatching. Past studies which support Walk and Gibson have failed to investigate whether chicks can discriminate visual depth immediately after hatching. Three hour-old chicks have been the youngest animals tested on the visual cliff; these chicks supported the Walk and Gibson hypothesis.

It is possible that learning of cues for depth discrimination might take place during the three hours before testing. As indicated by Kaess and Wilson (2) and Tallarico and Farrell (11) the direction of descent is in part due to the prior-to-testing rearing conditions. The present experiment attempted to reduce the amount of rearing time. Subjects aged 1-20 minutes and subjects 80-100 minutes old were tested on the visual cliff in an attempt to determine how early after hatching chicks can discriminate depth perception. If subjects aged 1-20 minutes and 80-100 minutes tend to descend to the shallow side of the visual cliff then these results would confirm the Walk and Gibson hypothesis. If, however, subjects descend to the deep side or randomly descend to both sides, rather than the shallow side, then some implications might be made concerning the possible early learning of visual depth cues. The prior-to-testing environment might play a greater role in depth discrimination than Walk and Gibson have stated.

CHAPTER II

METHOD

I. SUBJECTS

Seventy-two chicks (25 White Rocks and 47 New Hamshire Reds) were used in the present experiment. Group 1 had 25 subjects (Ss), Group 2 had 27 Ss, and Group 3 had 20 Ss. Subjects were hatched in an incubator (Sears, Roebuck & Company, Model 2130702) with a temperature of between 99-100 degrees and with the humidity above 80 per cent.

II. APPARATUS

The experiment was conducted in a sound-shielded room (7ft. by 7ft. by 7ft.) utilizing a two-way window for observation of responses by the experimentor. The visual cliff was constructed of plywood (7ft. by 3½ft. by ½in.). Two (2) inch painted red and white squares were the same dimensions for both sides of the visual cliff. The center board was constructed of wood (7ft. by 4in. by ½in.) and painted gray. The center board was installed 24 in. above the sound-shielded room floor. A small electric heater was used to supply a temperature of between 96-100 degrees in the experimental room.

No glass was used on either side of the visual cliff. In previous studies glass has been used on both the shallow and deep sides. It was beliefed that glass on the shallow side would produce less refraction than glass used on the deep side because of the additional distance the light travels under the deep side of the visual cliff.

The experimental room was indirectly lighted. One 100 watt light was located on both sides (deep and shallow) of the visual cliff. Both lights were 18in. below and directly facing the ceiling. Both lights were contained in 7in. long funnels so that all the light would reflect off the ceiling before hitting the visual cliff.

III. PROCEDURE

The general procedure was the same for all three groups. The time prior-to-testing and the testing situations were changed among the three groups. Direction of descent (either shallow or deep) and latency before moving were the observed measurements. Twenty-five fertilized eggs were placed in the incubator for 20 days. After the 20th day the fertilized eggs were checked every 15 minutes. Subjects were observed through a window in the incubator. One of the two experimentors observed the eggs continually. When all connections between chick and egg were severed the S was defined as hatched. Some chicks would hatch out of the egg but remain fastened to the shell longer than others. After a S had completely hatched, the time was noted and after the appropriate time (depending upon which group the S was in) had elapsed, the S was carried to and placed on the center board. All Ss were removed individually from the incubator and carried to the experimental room in the experimentor's hands. The Ss were individually cupped in the experimentor's hands stopping most outside visual sight while being carried to and placed on the center board. Each S was placed parallel on the center board, to the axis of the board, in the alternate direction of the previous S. After the S was placed on the Center board, the experimentor took two steps backwards (walked on the deep side of the cliff) and closed the door of the sound-shielded room. The experimentor was not in the room with the S during the testing. In most of the studies cited in the introduction, the experimentor stayed in the experimental room with the Ss during the testing. In the present experiment if the S did not descend to either side of the visual cliff within 30 minutes he was removed and a no-response was recorded. The three groups were run individually with two weeks separating each of the three testings.

IV. DESIGN

Three groups were used. Within Group 1 the shallow side of the visual cliff was 3/4in. beneath the center board while the deep side was 24 in. below the center board. Subjects in Group 1 were from 1 minute to 20 minutes old when placed on the center board. The visual cliff testing situation for Group 2 was exactly the same as that of Group 1, with the shallow side 3/4in. beneath the center board and the deep side 24in. below the center board. The Ss in Group 2 were 80-100 minutes old when placed on the center board. Group 3 was essentially a position control group for Group 2. Both sides of the visual cliff were 24in.

below the center board. Subjects in Group 3 were the same age as those of Group 2; 80-100 minutes. (See Figures 2 and 3).

GROUP	TESTING SITUATION	AGE
One	Deep side: 24" below the Center Board Shallow side: 3/4" below the Center Board	1-20 Minutes
Two	Deep side: 24" below the Center Board Shallow side: 3/4" below the Center Board	80-100 Minutes
Three	Deep side: 24" below the Center Board Shallow side: 24" below the Center Board	80-100 Minutes

FIGURE 2

DIAGRAM OF GROUPS

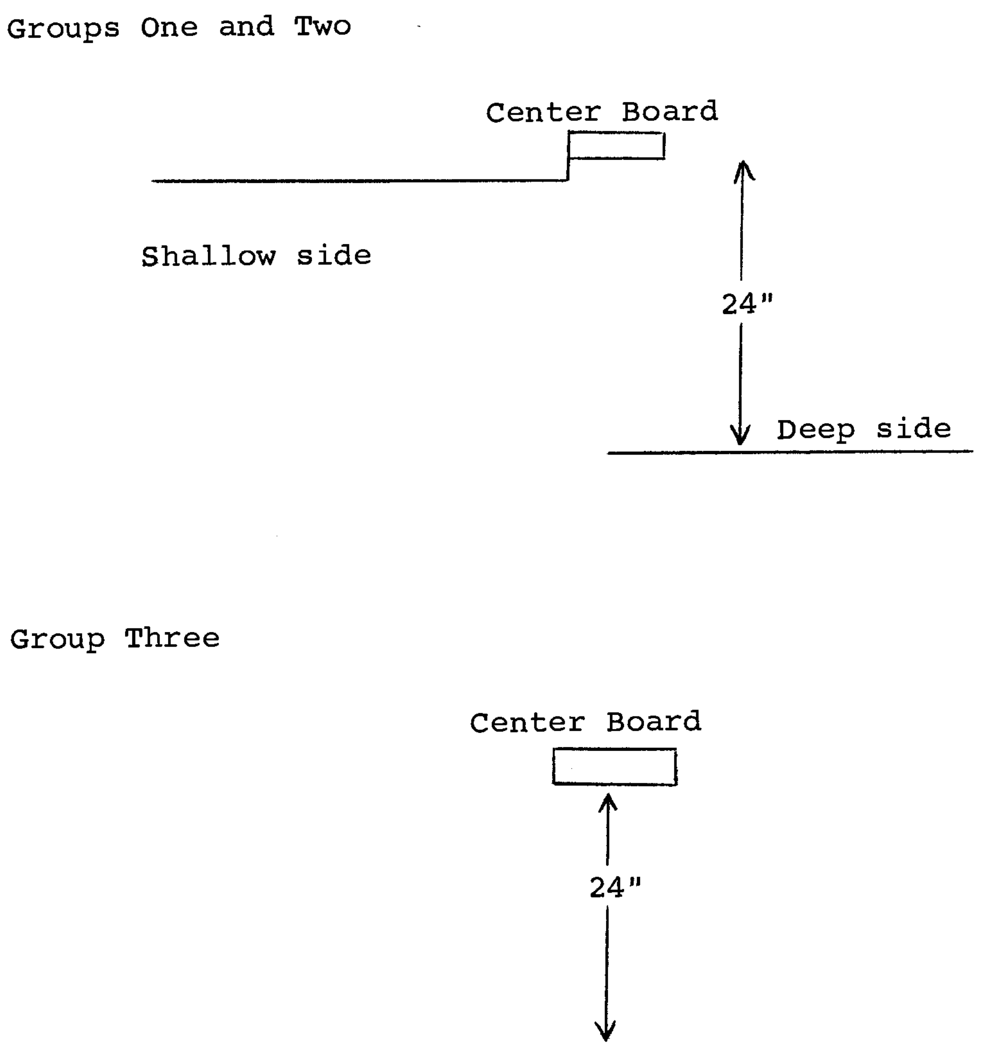

FIGURE 3

VISUAL CLIFF TESTING SITUATIONS

CHAPTER III

RESULTS

Six separate chi squares were calculated on the results of the experiment. Comparing the number of descents to the shallow side versus the number of descents to the deep side for Group 1 a non-significant ($X^2 = 1.31$, D.F. = 1, $P > .05$) chi square was found. Subjects randomly descended to both sides rather than to any one specific side. (See Table I).

When the number of shallow descents were compared with the number of deep descents in Group 2 a significant ($X^2 = 15.63$, D.F. = 1, $P < .01$) chi square was observed. Subjects descended to the shallow side of the visual cliff a significant number of times when 80-100 minutes old.

Within Group 3 the number of no-descents (subjects remained on the center board for 30 minutes) was compared with the total number of descents. A significant ($X^2 = 7.2$, D.F. = 1, $P < .05$) chi square was found demonstrating that with both sides of the visual cliff 24in. below the center board, for a full 30 minutes subjects would remain on the center board rather than descend 24 in.

TABLE I

COMPARISONS OF THE NUMBER OF DESCENTS
TO EACH SIDE OF THE VISUAL CLIFF

Group	Preference	Chi Square	D.F.	Probability
One	None	1.31	1	$P > .05$
Two	Shallow	15.63	1	$P < .01$
Three	Center Board	7.2	1	$P < .05$

Groups 1 and 2 were compared with Group 3 in terms of the number of no-descents. When Group 1 was compared with Group 3 a significant ($X^2 = 4.54$, D.F. = 1, $P < .05$) chi square was observed. Significantly more Ss in Group 3 remained on the center board a full 30 minutes. Comparing Group 2 with Group 3 a significant ($X^2 = 5.74$, D.F. = 1, $P < .05$) chi square was found indicating that Ss remained on the center board for 30 minutes rather than descend 24 inches. When Groups 1 and 2's no-descents were combined and compared with Group 3's no-descents, a non-significant ($X^2 = .694$, D.F. = 1, $P > .05$) chi square was found. (See Table II).

TABLE II

CHI SQUARE COMPARISONS OF THE NUMBER OF DESCENTS
TO EACH SIDE OF THE VISUAL CLIFF

Comparison	Preference	Chi Square	D.F.	Probability
Group 1 and Group 3	Center Board	4.54	1	$P < .05$
Group 2 and Group 3	Center Board	5.74	1	$P < .05$
Groups land2 and Group 3	None	.694	1	$P > .05$

CHAPTER IV

DISCUSSION

As the results indicate, subjects aged 1-20 minutes randomly descended to both sides of the visual cliff rather than to one specific (shallow) side as would be hypothesized by Walk and Gibson. Two possible suggestions or explanations exist as to why subjects did not descend to the shallow side a significant number of times: 1) Lack of motor coordination, and 2) insufficient time for the learning of depth cues.

As cited by Walk and Gibson (12), kittens ten days old lacked adequate motor coordination to physically move on the center board. Chicks 1-20 minutes old can and did walk about the center board, turn around, and orient their heads to both the shallow and deep sides of the visual cliff. At times a subject would advance toward the deep side, appear to perceive depth and try to back up. While trying to move away from the deep side, subjects would step on a wing or other foot and fall to the deep side of the visual cliff. The same process would occur on the shallow side. It was the experimentor's observed impression that some subjects who perceived depth and then fell to one side or the other lacked the motor coordination to step back or to catch its balance and right itself.

Films should be taken of the subject's behavior on the visual cliff and independent judges asked to judge or describe the behavior of the subjects. Using films the behavior on the visual cliff could be studied in more detail. Investigators have filed to study the process of decision-making (vicarious trial and error movement) in relation to the discrimination of depth. With the use of films, the number of times a subject moved from one side (deep) of the visual cliff to the other side (shallow) before descending could be counted.

Walk and Gibson have asserted that animals descend to the shallow side of the visual cliff at the time of locomotion. The results from Group 1 of the experiment would tend to suggest a qualification to that notion. A significant number of subjects did not descent to the shallow or the "safer" side at the time of locomotion.

The other suggestion to possibly explain non-significance at extreme early age (1-20 minutes) is the lack of sufficient time to learn depth cues. At the age of 1-20 minutes, subjects failed to discriminate depth but at 80-100 minutes, subjects significantly discriminated depth. During the time between 20 minutes and 80 minutes, the subjects either sufficiently learned enough cues for depth perception or the subjects matured to a point of being able to control their actions. The difference in time (60 minutes) resulted in a significant discrimination of depth.

Subjects aged 80-100 minutes displayed significant perception of depth. This result would tend to support Walk and Gibson's general conclusions. But the question still remains as to why subjects aged 1-20 minutes failed to discriminate depth while subjects only 60 minutes older did discriminate depth. What occurs in the additional time element has not been answered. As Kaess and Wilson (2) and Tallarico and Farrell (11) have demonstrated, the prior-to-testing environment plays a significant role in which side of the visual cliff the subject chooses. The additional one hour might have been sufficient time for the subjects to learn some depth cues.

Group 3 was specifically a position control group for Group 2; did subjects actually move to the shallow side of the visual cliff (as they did in Group 2) or did they move only to a specific side of the cliff? Did subjects move only to the left or only to the right? As stated previously subjects were alternately placed parallel on the center board. When a subject was placed facing east the shallow side was to his left and the deep side was to his right. When a subject faced west the shallow side of the visual cliff was on his right. As the results (Tables III and IV) indicate, there exists no pattern in relationship of direction placed on the center board and direction of descent. In Group 1 nine subjects moved to the left while ten descended to the right and six failed to descend. Eleven subjects descended to both the left and right while five failed to move in Group 2. Within Group 3 only one subject descended to the left, three moved to the right while sixteen failed to descend. Subjects moved either to the left or the right, depending on how they were placed on the center board, to get to the shallow side. Subjects did not just move to the right or to the left; they moved a significant number of times to the shallow side.

With both sides of the visual cliff lowered 24 inches below the center board and subjects 80-100 minutes old a

TABLE III

DIRECTION PLACED ON CENTER BOARD AND CORRESPONDING LEFT AND RIGHT CHOICES* (SEE TABLE IV)

Group	Direction Placed On Center Board	Number of Left, Right, And No-descents		
		Left	Right	No-descent
Group 1	East	(Shallow) 5	(Deep) 3	4
	West	(Deep) 4	(Shallow) 7	2
Group 2	East	(Shallow) 10	(Deep) 1	2
	West	(Deep) 1	(Shallow) 10	3
Group 3	East	(Shallow) 0	(Deep) 1	9
	West	(Deep) 1	(Shallow) 2	7
TOTALS	East	(Shallow) 15	(Deep) 5	15
	West	(Deep) 6	(Shallow) 19	12

TABLE IV

TOTAL RESPONSES TO BOTH SIDES*

Total responses to shallow side	34
Total responses to deep side	11
Total no-descents	27

*When subject was placed east:
Shallow side was on the left
Deep side was on the right

When subject was placed west:
Shallow side was on the right
Deep side was on the left

significant number of subjects remained on the center board a full thirty minutes. Rather than descend 24 inches the subjects remained on the center board. This tends to indicate that subjects did perceive depth and were not just descending to a specific side or in a specific direction.

The original plan of the experiment was to hatch individual eggs on the center board and observe their behavior for the first thirty minutes of life. Three subjects were tested in this fashion. Each time tested the subjects would crack the egg open with such force the chick immediately tumbled to one of the two sides. Two subjects plummeted to the deep side and one to the shallow side. When eggs were hatched on the center board, it was impossible to state that any subject had attempted to or did perceive depth. None of the three subjects were on the center board for more than forty-five seconds.

The presents results indicate both specific support and non-support for the Walk and Gibson hypothesis that subjects can discriminate depth at the time of "locomotion". The support or non-support depends upon how one defines the word "locomotion". Walk and Gibson have failed to operationally define the word "locomotion". If one operationally defines the word "locmotion" as walking four or more steps without falling over or tripping, then the present results would tend to refute the Walk and Gibson hypothesis. If "locomotion" implies smooth coordination when walking, the present results might then lend support for the general results of Walk and Gibson. Support would be gained for Walk and Gibson because subjects aged 80-100 minutes discriminated depth while younger subjects (1-20 minutes) failed to discriminate depth. The younger subjects showed signs of improper physical coordination. The present results indicate that chicks can significantly discriminate visual depth at an age of 80-100 minutes but fail to perceive depth at the younger age of 1-20 minutes. It appeared to the present investigator that chicks aged 1-20 minutes lack the necessary motor coordination to control themselves on the visual cliff. Generally the results lend support for the Walk and Gibson conclusions but many questions are left unanswered. What occurs during the additional hour from 20 minutes to 80 minutes that enables a subject to significantly discriminate depth? Does the subject learn more depth cues or physically become mature enough that he can discriminate depth?

The prior-to-testing environment was the inside of an incubator for the present experiment. The flat metal floor of the incubator produced the appearance of the shallow side of the visual cliff. Subjects were not given equal chances of optically viewing the appearance of the deep side of the visual cliff. This fact might explain why subjects in Group 2 descended to the shallow side.

Additional experimentation should be done in the area of physically hatching eggs on the center board. This would completely eradicate all possible human extraneous variables. Additional experimentation should be done concerning the decision-making process in relation to discrimination of depth. Films should be made of all behavior on the visual cliff and finer scales of measurement should be used.

CHAPTER V

SUMMARY

Three groups of subjects varied in age from 1-20 minutes to 80-100 minutes old. Two different visual cliff testing situations were used. For two of the groups the shallow side was 24 inches below the center board and the deep side was only three-quarters of an inch below the center board. The other group had the visual cliff 24 inches below the center board for both sides. The results indicate that subjects 1-20 minutes old cannot discriminate depth while subjects aged 80-100 minutes can discriminate depth. The results generally support the Walk and Gibson conclusions, but some questions were raised.

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